

# AI-Powered USB Handbook

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USB

*AI-Powered USB Handbook Team*

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Table of contents

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|     |  |    |
|-----|--|----|
| 1.  | AI-Powered USB Handbook                    | 3  |
| 1.1 |  | 3  |
| 1.2 |  | 3  |
| 2.  | 1 (Introduction)                           | 4  |
| 2.1 |  | 4  |
| 2.2 |  | 4  |
| 2.3 |  | 4  |
| 3.  | 2 USB (USB Connector Types)                | 5  |
| 3.1 | USB Type-A                                 | 5  |
| 3.2 | USB Type-B                                 | 6  |
| 3.3 | Mini USB & Micro USB                       | 7  |
| 3.4 | USB Type-C                                 | 8  |
| 4.  | 3 USB (USB Transfer Protocols)             | 10 |
| 4.1 |  | 10 |
| 4.2 | USB 3.x                                    | 10 |
| 4.3 | USB4                                       | 10 |
| 5.  | 4 Thunderbolt ( ) (Thunderbolt Technology) | 11 |
| 5.1 | Thunderbolt 3 ( 3)                         | 11 |
| 5.2 | Thunderbolt 4 ( 4)                         | 11 |
| 5.3 | Thunderbolt vs USB4                        | 11 |
| 6.  | 5 (Charging & Power Delivery)              | 12 |
| 6.1 |  | 12 |
| 6.2 |  | 12 |
| 6.3 |  | 17 |
| 6.4 |  | 17 |
| 6.5 | USB PD (Power Delivery)                    | 17 |
| 6.6 | (E-Marker )                                | 18 |
| 7.  | 6 (FAQ & Common Misconceptions)            | 19 |
| 7.1 | Q: Type-C                                  | 19 |
| 7.2 | Q: Type-C                                  | 19 |
| 7.3 | Q: 65W                                     | 19 |
| 7.4 | Q:   | 19 |

# 1. AI-Powered USB Handbook

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| AI-Powered USB Handbook           |     |                 |                    |
|-----------------------------------|-----|-----------------|--------------------|
| AI-Powered USB Handbook<br>Type-C | USB | USB 3.2 Gen 2x2 | Thunderbolt 4 ( 4) |

## 1.1

---

- -
- USB - USB
- USB -
- Thunderbolt -
- - USB PD
- -

## 1.2

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- 
- 
- 
- 

## 2. 1 (Introduction)

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### 2.1

---

|                                      |     |    |     |                 |
|--------------------------------------|-----|----|-----|-----------------|
| USB (Universal Serial Bus)<br>Type-C |     |    | USB | USB 3.2 Gen 2x2 |
| AI-Powered USB Handbook              | USB | AI |     |                 |

### 2.2

---

|  |   |      |  |  |
|--|---|------|--|--|
|  |   |      |  |  |
|  |   |      |  |  |
|  | 4 | USB4 |  |  |
|  |   | USB  |  |  |

### 2.3

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1.
2. USB 1.0 USB4
3. Intel Thunderbolt USB
4. USB PD PPS
5.

## 3. 2 USB (USB Connector Types)

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USB

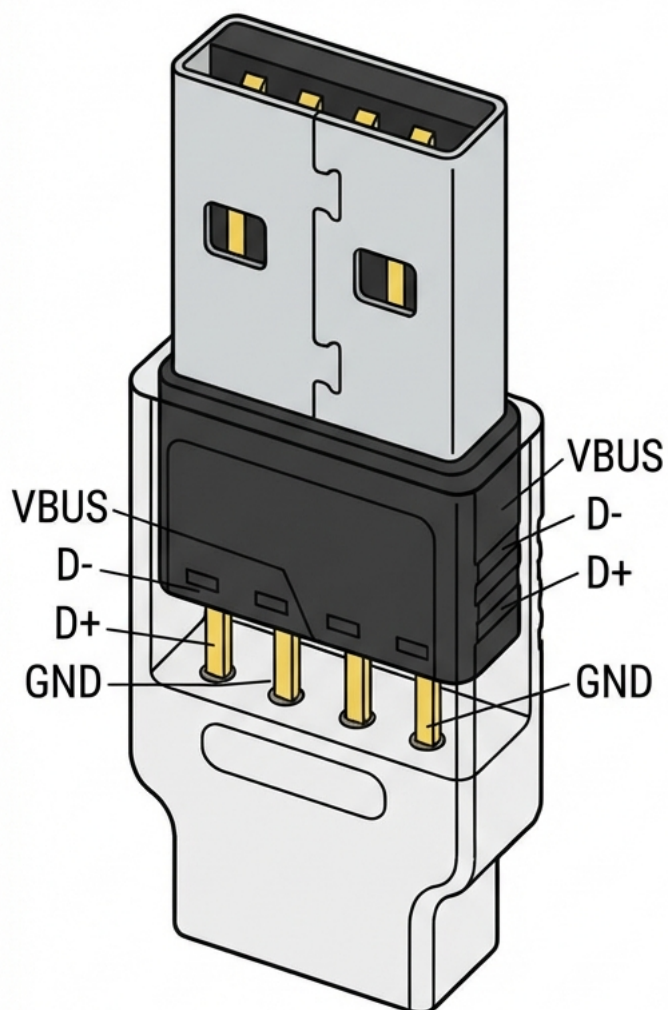
### 3.1 USB Type-A

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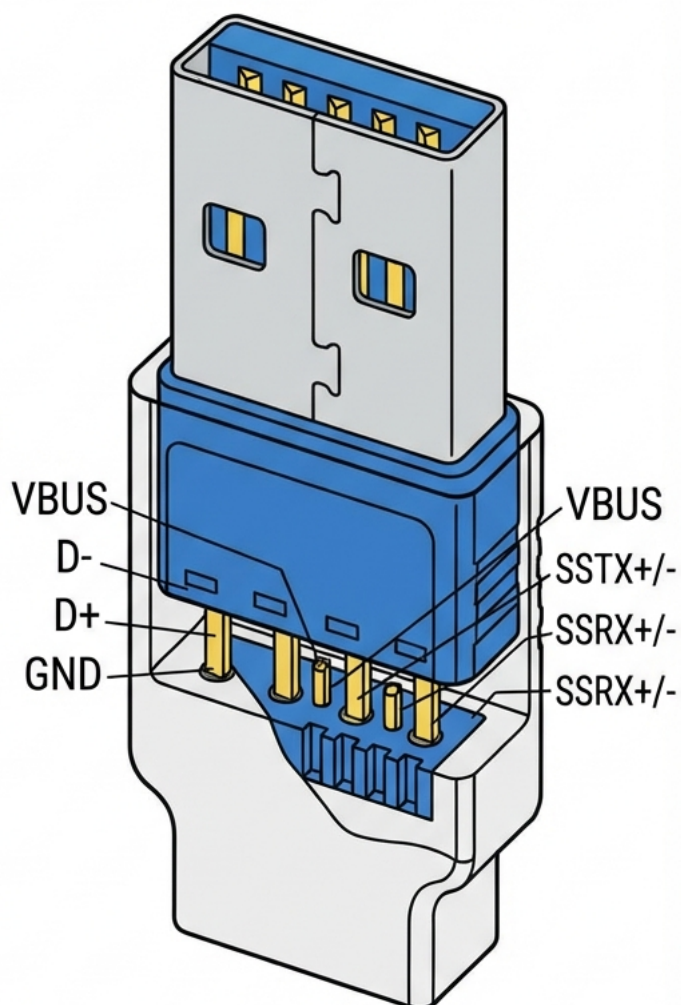
USB

- 
- 
- **USB 2.0** 4
- **USB 3.0+** 5 9

USB 2.0 Type-A



USB 2.0 Type-A

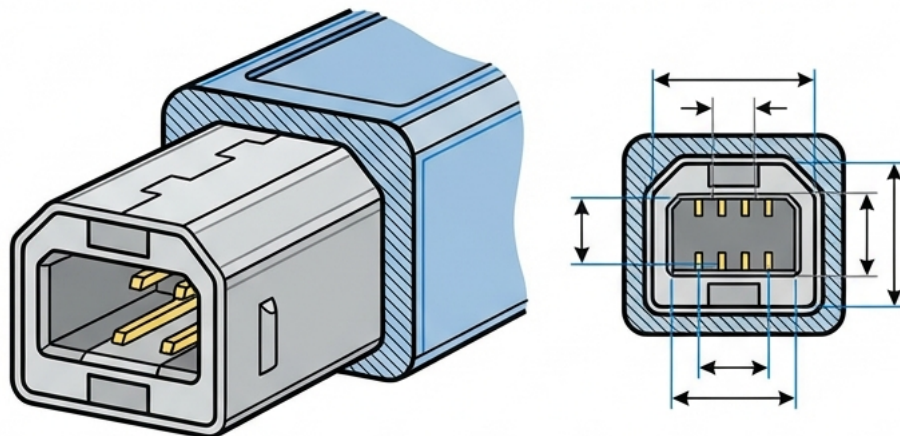
USB 3.0 Type-A  
(SuperSpeed)USB 3.0 Type-A  
(SuperSpeed)

### 3.2 USB Type-B

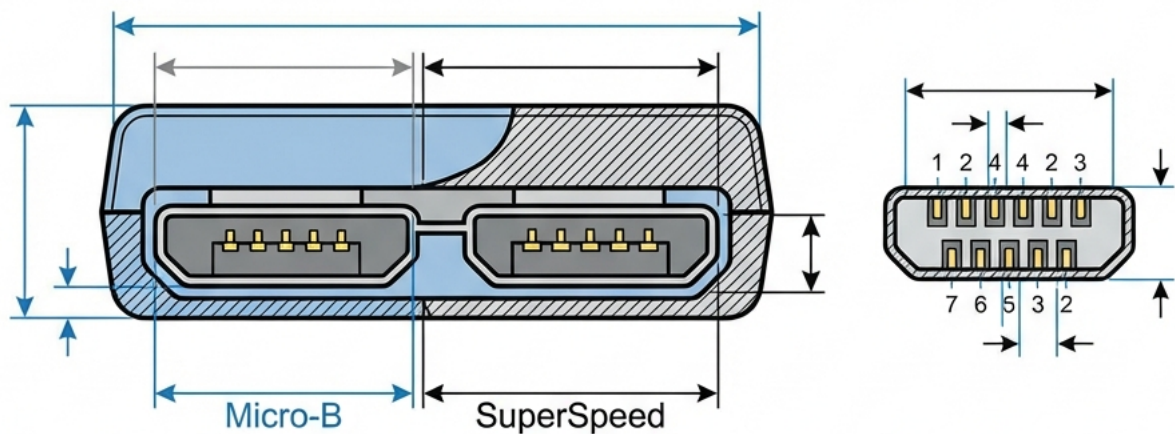
- Standard-B
- Micro-B (USB 3.0)

Elements

USB 3.0



USB Standard-B  
(Printer)



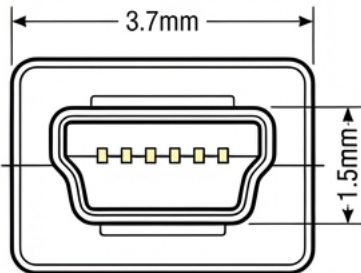
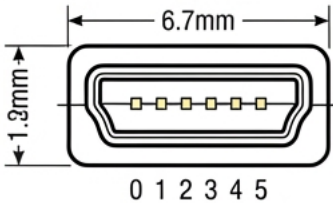
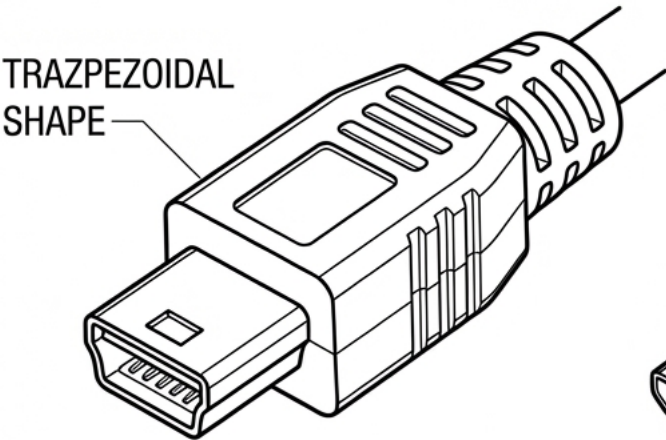
USB Micro-B SuperSpeed  
(External HDD)

### 3.3 Mini USB & Micro USB

- **Mini USB**    MP3
- **Micro USB**

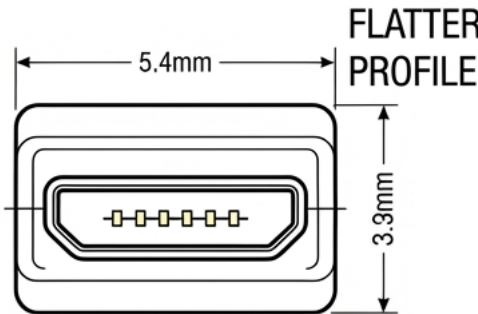
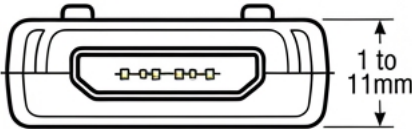
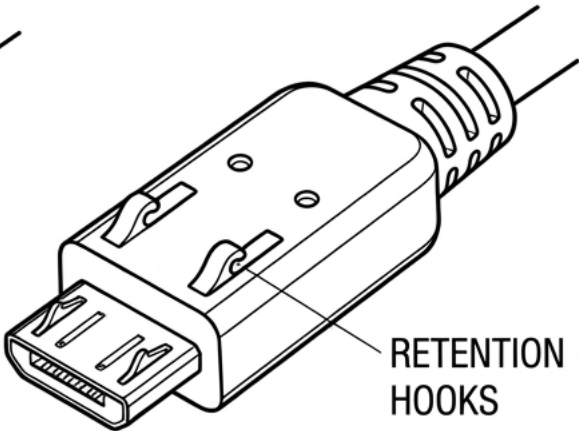
USB 2.0

# MINI USB



# MINI USB

# MICRO USB

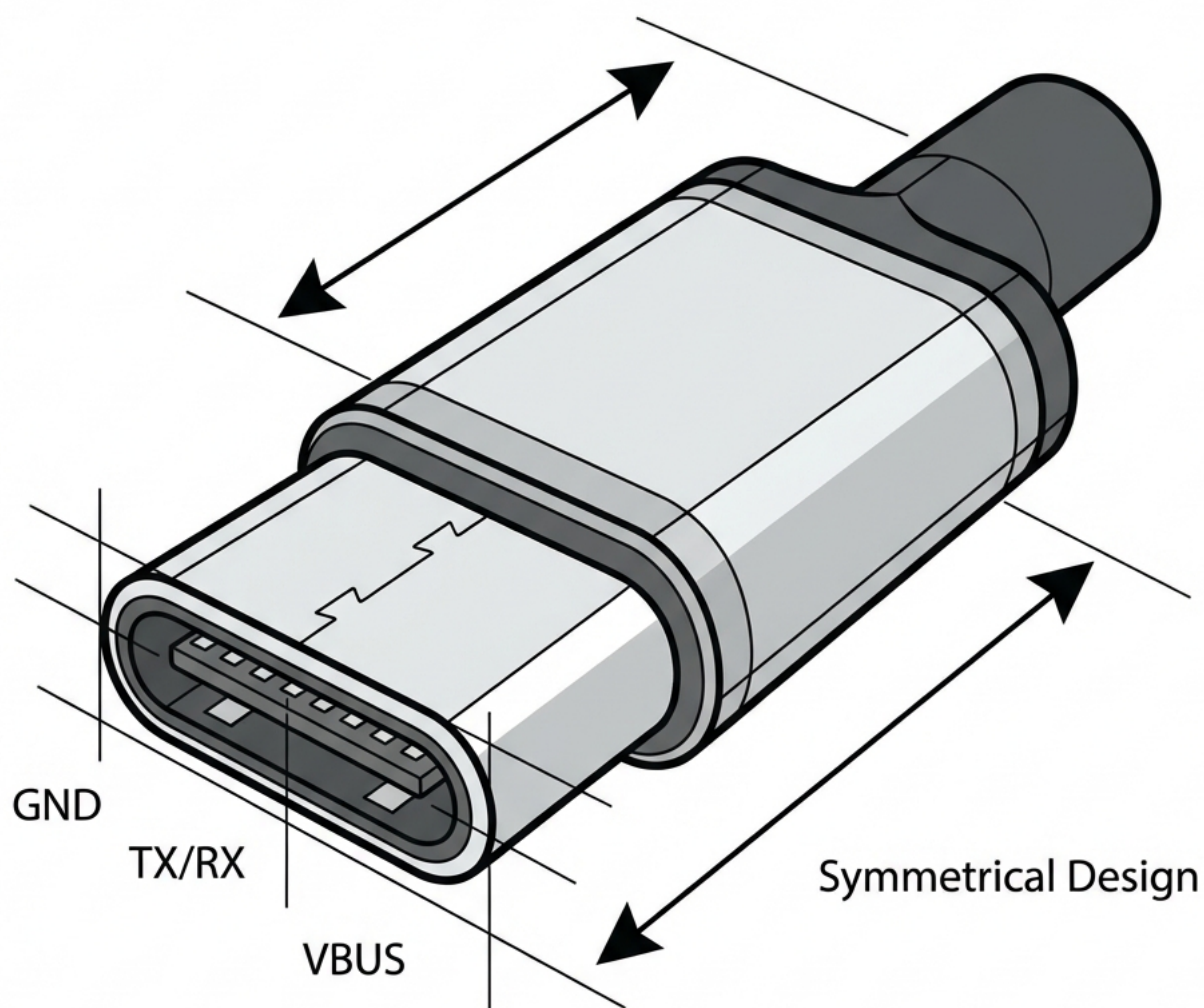


# MICRO USB

## 3.4 USB Type-C

|   |        |             |                            |        |
|---|--------|-------------|----------------------------|--------|
| • |        |             |                            |        |
| • |        |             |                            |        |
| • |        | DP Alt Mode | 240W                       | USB PD |
| • | 24     | 22          | CC (Configuration Channel) |        |
| • | Type-C | Type-C      | USB 2.0                    | 4      |





## 4. 3 USB (USB Transfer Protocols)

USB USB-IF (USB )

### 4.1

- **USB 1.0 / 1.1:**
- **Low Speed:** 1.5 Mbps ( )
- **Full Speed:** 12 Mbps
- **USB 2.0:**
- **High Speed:** 480 Mbps “ ”

### 4.2 USB 3.x

|         | (2013)        | (2019)          |                  |         |           |
|---------|---------------|-----------------|------------------|---------|-----------|
| USB 3.0 | USB 3.1 Gen 1 | USB 3.2 Gen 1   | USB 3.0 / 5Gbps  | 5 Gbps  | 8b/10b    |
| N/A     | USB 3.1 Gen 2 | USB 3.2 Gen 2   | USB 3.1 / 10Gbps | 10 Gbps | 128b/132b |
| N/A     | N/A           | USB 3.2 Gen 2x2 | USB 3.2 / 20Gbps | 20 Gbps | 128b/132b |

USB 3.2 Gen 2x2 Type-C Type-C

### 4.3 USB4

USB4 Intel Thunderbolt 3

- **USB4 Gen 2x2:** 20 Gbps
- **USB4 Gen 3x2:** 40 Gbps ( )
- 
- **(Tunneling)** (USB 3.2) (DisplayPort) PCIe
- USB 3.2 USB 2.0 Thunderbolt 3

## 5. 4 Thunderbolt ( ) (Thunderbolt Technology)

Thunderbolt Intel Apple “ ” “ ”

### 5.1 Thunderbolt 3 ( 3)

- USB Type-C
- 40 Gbps
- PCIe x4 ( ) DisplayPort ( 5K/8K ) USB
- 3 USB 3.x USB

### 5.2 Thunderbolt 4 ( 4)

4 40 Gbps

#### 5.2.1 4 vs 3

- |                |   |                |                    |          |               |     |
|----------------|---|----------------|--------------------|----------|---------------|-----|
| 1. <b>PCIe</b> | 4 | PCIe           | <b>32 Gbps</b> ( 3 | 16 Gbps) | (eGPU)        | SSD |
| 2.             | 4 | <b>4K</b>      | <b>8K</b> ( 3      | 4K)      |               |     |
| 3.             |   | Intel VT-d DMA | DMA                |          |               |     |
| 4.             | 4 | <b>(Hub)</b>   | 1 3                | 3        | (Daisy Chain) |     |

### 5.3 Thunderbolt vs USB4

- USB4 3
- 
- **USB4** “ ” 20Gbps 40Gbps PCIe
- **Thunderbolt 4** “ ” 40Gbps PCIe Intel
- **Thunderbolt 4** **USB4** “ ”

## 6. 5 (Charging & Power Delivery)

|     |                |      |
|-----|----------------|------|
| USB | 2.5W (5V 0.5A) | 240W |
|-----|----------------|------|

### 6.1

#### 6.1.1 USB BC 1.2 (Battery Charging)

|   |        |      |
|---|--------|------|
| USB BC 1.2  | USB-IF | 2010 |
| <ul style="list-style-type: none"><li>7.5W (5V 1.5A)</li><li>D+/D-</li><li></li><li><b>SDP (Standard Downstream Port)</b> USB 500mA</li><li><b>CDP (Charging Downstream Port)</b> + 1.5A</li><li><b>DCP (Dedicated Charging Port)</b> 1.5A</li><li></li></ul> |        |      |

### 6.2

|        |       |   |
|--------|-------|---|
| USB PD | D+/D- | / |
|--------|-------|---|

#### 6.2.1

|                       |       |  |
|-----------------------|-------|--|
| Handshake Protocol    |       |  |
| 1.                    | 5V    |  |
| 2.                    | D+/D- |  |
| 3.                    |       |  |
| 4.                    | /     |  |
| 5.                    |       |  |
| [!NOTE] D+/D- USB " " |       |  |

#### 6.2.2 Quick Charge (QC)

|   |         |
|---|---------|
| Quick Charge  | Android |
| <b>QC 1.0 (2013)</b>  |         |
| <ul style="list-style-type: none"><li>10W (5V 2A)</li><li></li><li></li></ul> |         |

QC 2.0 (2014)

QC 2.0

- 18W
- 
- Class A: 5V 9V 12V
- Class B: 5V 9V 12V 20V
- 3A
- D+/D-
- 5V D+ = D- = 0.6V
- 9V D+ = 3.3V, D- = 0.6V
- 12V D+ = 0.6V, D- = 0.6V
- 20V D+ = 3.3V, D- = 3.3V Class B

QC 3.0 (2016)

QC 3.0

- 18W 22W
- 3.6V - 20V
- 200mV QC 2.0
- 
- 
- 38% QC 2.0
- 
- QC 2.0

QC 4 / QC 4+ (2017-2018)

QC 4/4+ USB PD

- 28W (QC 4) 100W (QC 4+)
- 
- USB PD 3.0 PD
- PPS (Programmable Power Supply)
- INOV (Intelligent Negotiation for Optimum Voltage)
- QC USB PD
- 

QC 5 (2020)

- 100W+
- 98%
- USB PD QC

[!IMPORTANT] QC 4 USB PD QC 4+ PD iPhone MacBook

6.2.3 OPPO VOOC

OPPO VOOC

VOOC (2014)

- 20W
- / 5V 4A
- 
- QC 5V 4A-5A
- 7 Micro-USB 5 2
- 
- MCU ( )
- 
- 
- 
- 

SuperVOOC (2018)

SuperVOOC

- 50W
- / 10V 5A
- 
- 2000mAh
- 10V 5V
- 5V 10V 5A
- 

SuperVOOC 2.0 (2019-2020)

- 65W
- / 10V 6.5A
- OPPO Find X Reno

125W / 240W (2021-)

OPPO - 125W 10V 12.5A - 240W 24V 10A

[!WARNING] VOOC OPPO Type-C VOOC

6.2.4 FCP / SCP

FCP (Fast Charge Protocol, 2015)

- 18W

- 9V / 12V
- 2A
- D+/D-
- 

SCP (SuperCharge Protocol, 2016)

- SCPVOOC
- - SCP 1.0 22.5W (5V 4.5A 4.5V 5A)
  - SCP 2.0 40W (10V 4A )
  - SCP 3.0 66W (11V 6A)
  - 
  - 
  - 
  - 
  - FCP

[!NOTE] FCP SCP SCP FCP FCP FCP FCP SCP

6.2.5 Pump Express (PE / PE+)

Pump Express Plus (PE+, 2015)

- 18-24W
- 5V - 12V
- 
- D+/D-
- 
- 
- QC

Pump Express 3.0 (PE 3.0, 2017)

- 30W
- 3V - 6V
- **USB Type-C** Type-C
- 20 70%

USB PD PE

6.2.6 vivo FlashCharge

|   |   |   |
|---|---|---|
| vivo  | " | " |
| (2016)  |   |   |
| <ul style="list-style-type: none"><li>22.5W</li><li>/ 9V 2.5A 5V 4.5A</li><li></li></ul>    |   |   |
| FlashCharge 2.0   |   |   |
| <ul style="list-style-type: none"><li>44W 55W 66W 120W 200W</li><li></li><li>vivo</li></ul> |   |   |

6.2.7

|   |  |  |
|---|--|--|
| (Mi Turbo Charge)   |  |  |
| <ul style="list-style-type: none"><li>18W 27W 33W 67W 120W 210W</li><li></li><li>QC 3.0</li><li>+ USB PD</li><li>QC</li></ul> |  |  |

6.2.8 (mCharge)

|   |  |  |
|---|--|--|
| <ul style="list-style-type: none"><li>18W 24W 36W</li><li>QC</li><li></li></ul> |  |  |
|---|--|--|

6.2.9 AFC (Adaptive Fast Charging)

|   |                  |  |
|---|------------------|--|
| <ul style="list-style-type: none"><li>15W 18W</li><li>9V</li><li>1.67A (15W) 2A (18W)</li><li>D+/D-</li><li>QC 2.0 9V</li></ul> |                  |  |
| [!TIP]  | USB PD + PPS AFC |  |



6.3

|                |          |                     |    |
|----------------|----------|---------------------|----|
|                |          |                     |    |
| QC 2.0/3.0     | 18W      |                     |    |
| QC 4+          | 100W     | USB PD              | PD |
| VOOC/SuperVOOC | 20-240W  | OPPO/OnePlus/realme |    |
| FCP            | 18W      | /                   |    |
| SCP            | 22.5-66W | /                   |    |
| PE/PE+         | 18-24W   | MTK                 |    |
| AFC            | 15-18W   | QC                  |    |

6.4

6.4.1

- 
- 5V 1A/2A
- 
- QC 2.0/3.0 9V
- QC + FCP

6.4.2

- VOOC
- 
- 

6.4.3 USB PD

|              |       |            |      |            |       |    |
|--------------|-------|------------|------|------------|-------|----|
| [!IMPORTANT] |       | USB PD 3.0 | PPS  | Type-C     |       |    |
| -            | QC 4+ | USB PD -   | PD - | PD + PPS - | OPPO/ | PD |

6.4.4

- 1.
- 2.
3. USB PD USB PD
- 4.

6.5 USB PD (Power Delivery)

|        |        |        |
|--------|--------|--------|
| USB PD | USB-IF | Type-C |
|--------|--------|--------|

6.5.1

- **PD 2.0 / 3.0:**    **100W** (20V 5A)
- 5V, 9V, 15V, 20V
- **PD 3.1:**        **EPR (Extended Power Range)**    **240W**
- 28V, 36V, 48V

6.5.2 PPS (Programmable Power Supply)

|     |        |             |   |   |   |   |     |
|-----|--------|-------------|---|---|---|---|-----|
| PPS | PD 3.0 | <b>20mV</b> | - | - | “ | ” | PPS |
|-----|--------|-------------|---|---|---|---|-----|

6.6            (E-Marker    )

Type-C

- **3A**            C-to-C            60W (20V 3A)
- **5A**            **E-Marker**            “    5A    ”            100W (20V 5A)
- **EPR**            PD 3.1 240W

7. 6 (FAQ & Common Misconceptions)

7.1 Q: Type-C

A: 1. USB 2.0 E-Marker 3A 65W/100W 2. PD  
VOOC 10W 3.

7.2 Q: Type-C

A: Type-C C -9.9 + USB 2.0 - USB 3.2 (10Gbps) + 4K + 100W - 4 40Gbps  
+ 8K + 240W Logo

7.3 Q: 65W

A: USB PD “ ” “ 9V 2A ” 18W PD 5V 1A 5V 2A

7.4 Q:

A: - 5A 4 - USB 3.2